LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA8 | The Chalfonts and Amersham

Flood risk assessment (WR-003-008)

Water resources

November 2013

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Department for Transport

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Contents

1 Introduction 1

1.1 Structure of the water resources and flood risk assessment appendices 1

1.2 Scope and structure of this assessment 1

1.3 Location 1

2 Flood risk assessment methodology 4

2.1 Source-pathway-receptor model 4

2.2 Flood risk categories 4

2.3 Regional and local flooding planning policy documents 5

3 Design criteria 9

4 Data sources 10

4.1 Primary datasets 10

4.2 Site familiarisation visits 10

5 The proposed development 11

5.1 Topography and land use 11

5.2 Local flood risk receptors 11

5.3 Description of the Proposed Scheme 13

6 Existing flood risk 15

6.1 Historical flooding incidents 15

6.2 Risk of flooding from rivers 15

6.3 Risk of flooding from surface water 16

6.4 Risk of flooding from groundwater 19

6.5 Risk of flooding from drainage systems 20

6.6 Risk of flooding from artificial sources 20

6.7 Summary of baseline flood risk 20

7 Flood risk management measures 22

7.1 Risk of flooding from rivers 22

7.2 Risk of flooding from surface water 22

7.3 Risk of flooding from groundwater 23

7.4 Risk of flooding from drainage systems 23

7.5 Risk of flooding from artificial sources 23
8 Post-development flood risk assessment 24
8.1 Local receptors 24
8.2 Impact on risk of flooding from rivers 26
8.3 Impact on risk of flooding from surface water 27
8.4 Impact on risk of flooding from groundwater 28
8.5 Impact on risk of flooding from drainage systems 29
8.6 Impact on risk of flooding from artificial sources 29
8.7 Summary of potential impacts and effects on flood risk 30
9 Conclusions 32
9.1 Summary 32
9.2 Residual flood risks to Proposed Scheme 32
9.3 Residual effects of the Proposed Scheme on flood risk 33
9.4 Compliance with local planning policy 33
10 References 35

List of figures

Figure 1: The Chalfonts and Amersham area 2
Figure 2: 1 in 200 years return period (0.5% annual probability) surface water flood extent and Environment Agency Flood Zone Map at Chalfont St Giles vent shaft 17
Figure 3: 1 in 200 years return period (0.5% annual probability) surface water flood extent and Environment Agency Flood Zone Map at Amersham vent shaft 18

List of tables

Table 1: Flood risk category matrix for all flooding sources 5
Table 2: Flood risk assessment data sources 10
Table 3: Vulnerability of local receptors in CFA8 11
Table 4: Summary of baseline flood risk for all sources of flooding in CFA8 20
Table 5: Shared flood risk pathways in CFA8 24
Table 6: Summary of potential flood risk impacts and effects in CFA8 30

1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

1.1.1 The water resources and flood risk assessment appendices comprise three parts. The first of these is a route-wide appendix (Volume 5: Appendix WR-001-000).

1.1.2 Specific appendices for each community forum area (CFA) are also provided. For The Chalfonts and Amersham area (CFA8), these are:

- a water resources assessment (Volume 5: Appendix WR-002-008); and
- a flood risk assessment (i.e. this appendix).

1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

1.2 Scope and structure of this assessment

1.2.1 This flood risk assessment (FRA) considers the assessment of flood risk in CFA8. The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)[1] which aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe without increasing flood risk elsewhere.

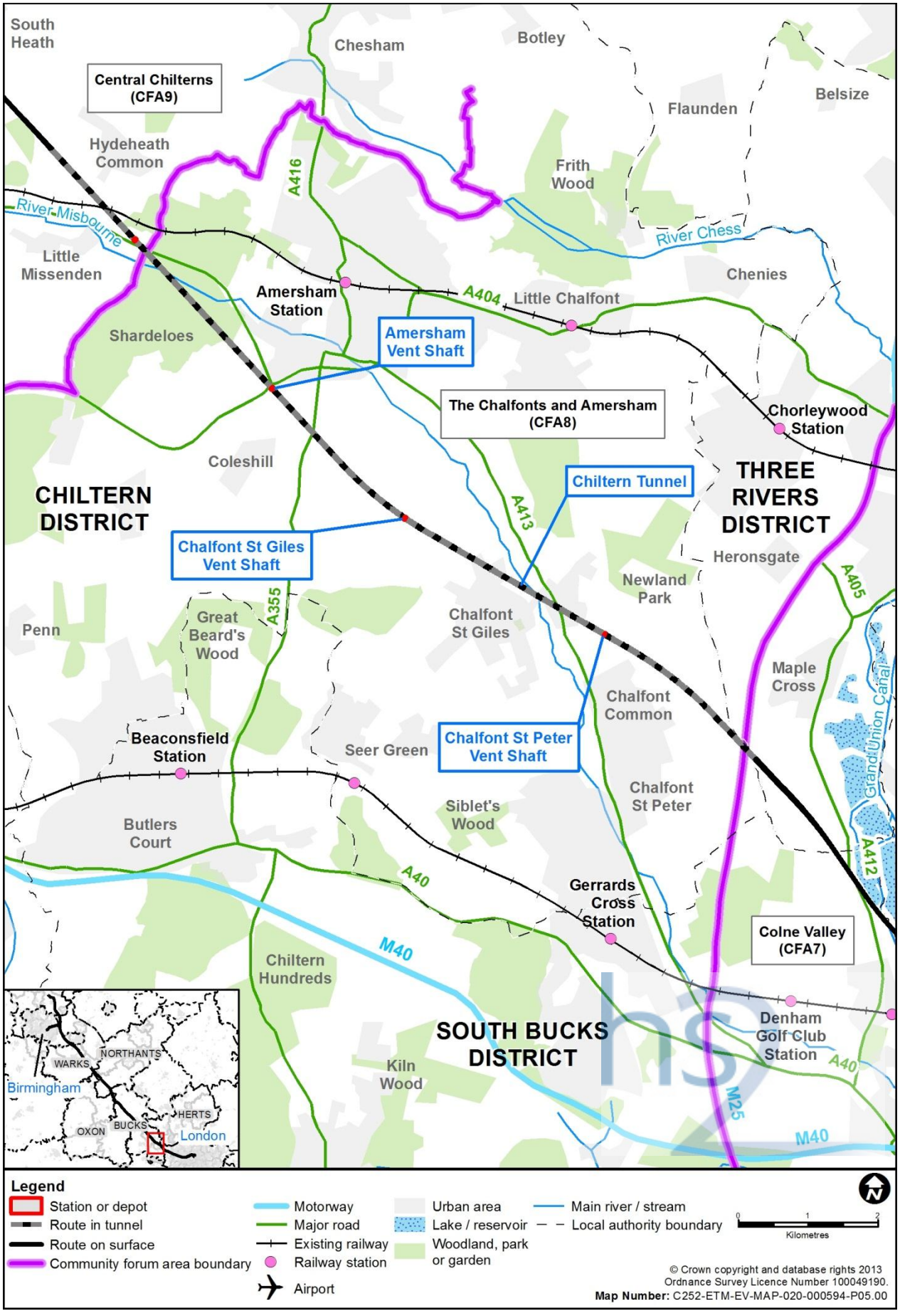
1.2.2 The FRA methodology and a review of the relevant local planning policy documents are provided in Section 2 of this report. The design criteria are provided in Section 3 and Section 4 documents the sources of information that have been reviewed. Section 5 provides a description of the planned works within CFA8. Section 6 considers baseline flood risk and the risk of flooding to the Proposed Scheme from all relevant sources. Flood risk mitigation measures included within the Proposed Scheme are detailed in Section 7. The effect of the Proposed Scheme on the risk of flooding is considered in Section 8.

1.3 Location

1.3.1 CFA8 covers a section of the route that is 11.3km in length as it passes through the Chiltern District in the county of Buckinghamshire. As shown in Figure 1, the Colne Valley area (CFA7) is located to the south and the Central Chilterns area (CFA9) lies to the north. The study area extends to a distance of 1km from the centre line of the route and includes the northern portion of Chalfont St Peter, Chalfont St Giles and Amersham Old Town.

[1] Department for Communities and Local Government (2012), *National Planning Policy Framework*.

Figure 1: The Chalfonts and Amersham area



1.3.3 The area extends from the M25, east of Chalfont St Peter, to the junction of the A413 and Mop End Lane. It includes land within the parishes of Chalfont St Peter, Chalfont St Giles, Coleshill and Amersham. The corresponding council wards are Chalfonts St Giles, Chalfont Common, Penn and Coleshill and Amersham Town.

1.3.4 The route through this area will be entirely in deep twin-bore tunnels with three associated ventilation and intervention shafts (vent shafts) in this area, near Chalfont St Peter, Chalfont St Giles and Amersham respectively (see Maps CT-06-023b to CT-06-030a, Volume 2, CFA8 Map Book).

2 Flood risk assessment methodology

2.1 Source-pathway-receptor model

2.1.1 Flood risk is assessed using the source-pathway-receptor model. In this model individual sources of flooding within the study area are identified. The primary source of flooding is rainfall, which is a direct source in the short-term (surface water flooding) and can lead to flooding from watercourses (river flooding) and overloaded man-made collection systems (sewer flooding) in the short- or medium-term. Stored rainfall, either naturally in below ground aquifers and natural lakes or artificially in impounded reservoirs and canals can lead to flooding when the storage capacity of the system is exceeded. A final source of flooding arises from tidal effects and storm surges caused by low pressure systems over the sea.

2.1.2 For there to be a risk of flooding at an individual receptor there must be a pathway linking it to the source of flooding. The pathways within the study area are assessed by reviewing national datasets that show the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 Receptors considered in this assessment include the Proposed Scheme and existing development within 1km of the Proposed Scheme. The Proposed Scheme includes all associated permanent infrastructure. Areas of interest are identified through comparison of the national spatial datasets with the design drawings. Where a risk is identified mitigation is proposed in line with recommendations in the NPPF.

2.1.4 Existing receptors within the study area are identified using Ordnance Survey (OS) mapping information. A high-level screening assessment is then undertaken to identify receptors that are within or in close proximity to an area of flood risk via pathways indicated using the flood risk data sources listed below. The vulnerability of each receptor is classified using Table 2 of the NPPF Technical Guidance Document[2].

2.1.5 The assessment then considers the vulnerability of the receptor with reference to the flood risk category of the source using Table 3 of the NPPF Technical Guidance Document and assesses whether the Proposed Scheme has any potential to influence or alter the risk of flooding to each receptor. Where such potential has been identified, mitigation is proposed based on further analysis.

2.2 Flood risk categories

2.2.1 The level of flood risk is categorised by assessing the design elements against the datasets for each source. A matrix showing the flood risk category associated with each flooding source is presented in Table 1.

[2] Department for Communities and Local Government (2012), *National Planning Policy Framework Technical Guidance.*

Table 1: Flood risk category matrix for all flooding sources

Source of flooding	Flood risk category				
	No risk	**Low**	**Medium**	**High**	**Very high**
Rivers		Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Surface water	No surface water flooding.	Surface water flooding <0.3m for 1 in 200 years event.	Surface water flooding >0.3m for 1 in 200 years event; and Surface water flooding <0.3m for 1 in 30 years event.	Surface water flooding >0.3m for 1 in 30 years event.	
Groundwater		Very low-low	Moderate	High-very high	
Drainage and sewer systems	No sewer in vicinity of site.	Surcharge point >20m from site and no pathways.	Surcharge point within 20m of site and restricted pathways.	Sewer network crosses site and pathways exist.	
Artificial sources	Outside of inundation mapping/no pathway exists.	Within inundation mapping/ pathway exists.			

2.3 Regional and local flooding planning policy documents

2.3.1 The lead local flood authority (LLFA) for the study area is Buckinghamshire County Council (BuCC). The recommendations from the BuCC Preliminary Flood Risk Assessment (PFRA)[3], undertaken in accordance with the Flood Risk Regulations 2009[4], have been reviewed in undertaking this assessment. The draft BuCC local flood risk management Strategy (LFRMS)[5] is at the consultation stage and was published in February 2013. The local planning authority for this study area is Chiltern District Council (ChDC). The Core Strategy for ChDC forms part of the local development framework (LDF), and was adopted in November 2011.

2.3.2 In addition to the above documents BuCC produced a surface water management plan for Chesham and High Wycombe[6] in November 2011. This document only covers these two towns and as such is not applicable to areas within this study area.

Buckinghamshire County Council Preliminary Flood Risk Assessment

2.3.3 The BuCC PFRA confirms that there are no indicative flood risk areas of national significance within Buckinghamshire. Consequently only Stage 1 of the Flood Risk Regulations 2009 process has been completed.

[3] Jacobs (2011), *Buckinghamshire County Council Preliminary Flood Risk Assessment*.
[4] *Flood Risk Regulations 2009* (SI 2009 No.3042). London, Her Majesty's Stationery Office.
[5] Buckinghamshire County Council (2013), *Buckinghamshire County Council Local Flood Risk Management Strategy 2013 – 2018*.
[6] Jacobs (2011), *Buckinghamshire Country Council Surface Water Management Plan for Chesham and High Wycombe*.

2.3.4 The most significant historical flood event in Buckinghamshire was caused by high groundwater levels across the Chalk aquifers resulting in high river flows and widespread groundwater flooding in the valleys of the Chiltern Hills. The flooding occurred in the winter of 2000-2001 and is considered to have had "significant harmful consequences".

2.3.5 The BuCC PFRA recognises that the construction and engineering of the Proposed Scheme may have a significant impact upon surface water flows. For example embankments and cuttings may, without suitable design solutions, may impede the flow of small watercourses and surface runoff.

Buckinghamshire County Council Local Flood Risk Management Strategy

2.3.6 The BuCC LFRMS[7] guides the planning process in relation to flood risk across all categories. The LFRMS outlines key policies in relation to development within Buckinghamshire. Specific policies of relevance to the Proposed Scheme are:

- "Policy 6 – the LLFA will seek to reduce the risk of flooding now in a way which does not compromise the interconnected needs of the economy, society and environment in the future"; and
- "Policy 15 – sustainable drainage systems (SuDS) should be used in new developments to reduce the rate and volume of surface water. Design of SuDS to meet national standards and to be adopted by the SuDS Approval Body. SuDS are expected to provide natural removal of pollutants and sediments, promote aquifer recharge, enhanced biodiversity, add aesthetic value and be easily maintainable."

Thames Region Catchment Flood Management Plan

2.3.7 The River Misbourne (a tributary of the River Colne) passes through CFA8 and falls within the Thames Region Catchment Flood Management Plan (CFMP)[8] which covers the extent of the Thames basin. The main objectives of the Thames Region CFMP revolve around the high risk of flooding to key urban centres and the predicted future increase in flood risk due to climate change. The Thames Region CFMP 'sub-area 4' covers chalk and downland catchments and includes the Colne Tributaries and Wye, Middle Mole, Thame and Upper Lee.

2.3.8 Within the Chilterns the major source of flooding is rivers in combination with high groundwater levels. Many of the river valleys in the area are quite steep, with narrow floodplains. Within some urban areas modifications of the river channel have occurred and bridge structures and culverts can exacerbate local flooding.

2.3.9 There are 2,060 properties with a 1% risk of flooding along the Colne tributaries and Wye. Within all the chalk and downland catchments there are approximately 4,000 properties at risk of flooding, which represents 3% of the total number at risk in the Thames Region. Since the land area covered makes up 11% of the region the policy

[7] Buckinghamshire County Council (2013), *Buckinghamshire County Council Local Flood Risk Management Strategy 2013 – 2018.*
[8] Environment Agency (2007), *Thames Region Catchment Flood Management Plan*.

therefore considers flood risk in these areas at 'moderate' level and as such indicates that they will not be a priority for funding of large scale flood defences. Proposed actions for these catchments include maintaining the existing river system capacity and looking for opportunities to make it more efficient, working with local planning authorities to retain remaining floodplain and increasing public awareness.

Chiltern District Council Strategic Flood Risk Assessment

2.3.10 The ChDC Level 1 Strategic Flood Risk Assessment (SFRA)[9] and supporting mapping has been updated following publication of the original ChDC SFRA in 2008 and provides key information and advice on planning policy within the development area and is often used as a basis for policy setting and planning decisions.

2.3.11 The updated ChDC SFRA focuses on more detailed mapping of critical drainage areas (CDA) which are most at risk of flooding from surface water, groundwater and ordinary watercourses. The ChDC SFRA states that SuDS should be a priority in these areas. The Environment Agency Flood Map for Surface Water (FMfSW) was agreed as the best available representation of areas susceptible to local level flooding and the 1 in 200 years FMfSW mapping is used to define dry valleys and CDA.

2.3.12 The ChDC SFRA also records historical incidences of flooding from all sources. The predominant source of flooding within the study area is localised surface water incidents predominantly in urban areas. The ChDC SFRA also identifies the need to deal with the issue of sewer flooding in Chalfont St Peter.

2.3.13 The document has been updated to be consistent with the draft BuCC LFRMS and consequently the ChDC SFRA seeks to consider adaptations to climate change, promote integrated flood risk management and sustainable management of land and local flood risk, improve recording of flood incidents, promote the use of SuDS including at homeowner level to reduce urban creep, and, improve communication and involvement of partners, stakeholders and the general public.

2.3.14 Overall the ChDC SFRA recommends promoting development and designs that reduce the overall risk of flooding and seeks to ensure that development results in a positive reduction in flood risk to the district whether through reducing the frequency or severity of flooding.

2.3.15 The ChDC Level 2 SFRA[10] was completed in June 2008 following the initial Level 1 report. It analyses all potential development sites in light of findings of the Level 1 document and provides a summary of potential risks to inform the sequential test. The document states that the 'primary objective of this Level 2 ChDC SFRA is to ensure that the risk of flooding can be realistically mitigated through the design process'. Outcomes of the assessment conclude that it is 'imperative that the development control process emphasises the critical importance of flood risk, influencing the design process accordingly'.

[9] Jacobs (2013), *Chiltern District Council Strategic Flood Risk Assessment- Level 1 Update.*
[10] Jacobs (2008), *Chiltern District Council Strategic Flood Risk Assessment- Level 2.*

Core Strategy for Chiltern District Council

2.3.16 The Core Strategy for ChDC[11] forms part of the local development framework and was adopted in November 2011. It is the overarching key plan in the local development framework and is of specific relevance to flood risk and development covering the following points:

- sites in Flood Zones 2 and 3 are not suitable for development since the capacity of the floodplain will be reduced and the flow of floodwater impeded. This will increase the severity of flooding and also increase the risk of flooding elsewhere;
- support will be given to proposals to reduce the vulnerability of existing developments and land uses within the floodplain; and
- consideration of local flooding, as indicated by CDA mapping in the ChDC SFRA, should be an integral part of design and measures must be taken to reduce the flood risk.

2.3.17 Policy CS4 outlines measures the council should implement to ensure that development is sustainable with a focus of the incorporation of SuDS. This is of particular importance in identified CDA to ensure that development will not increase the risk of flooding within the site or to adjoining land and/or properties. It also promotes seeking options to reduce the risk of flooding in appropriate circumstances as a result of new development.

[11] Chiltern District Council (2011), *Core Strategy for Chiltern District, adopted November 2011.*

3 Design criteria

3.1.1 It is a requirement of the design that the Proposed Scheme shall be protected against flooding from any source during the 1 in 1,000 years return period (0.1% annual probability) rainfall event, with water levels not rising closer than 1m to the top of rail level.

3.1.2 In accordance with the NPPF, an allowance for climate change is included in the assessment by assuming that peak rainfall intensity will increase by 30% and that peak river flows will increase by 20%.

4 Data sources

4.1 Primary datasets

4.1.1 Consistent with the requirements of the NPPF this assessment considers the risk of flooding from rivers, direct surface water runoff, rising groundwater, overwhelmed drainage and sewer systems, and artificial sources such as reservoirs, lakes and canals.

4.1.2 The Proposed Scheme lies entirely outside the extent of flooding from the sea and therefore the risk of flooding from tidal sources is not considered in this assessment.

4.1.3 The primary datasets for each source of flooding used to assess the design elements are presented in Table 2. A high-level review of the risk of flooding and potential impacts is undertaken on the basis of these datasets across all flood sources. Where this review indicates potentially significant impacts on the risk of flooding or a risk of flooding to the route, further investigation in the form of hydraulic modelling is undertaken.

Table 2: Flood risk assessment data sources

Source of flooding	Datasets reviewed	Data owner
Rivers	Flood zone mapping. Detailed River Network (DRN). Catchment hydraulic models.	Environment Agency
Surface water	FMfSW. Local surface water flood mapping.	Environment Agency LLFA
Groundwater	Areas susceptible to groundwater flooding. 1:50,000 geological mapping (superficial and bedrock). Potential for elevated groundwater.	British Geological Survey (BGS) LLFA
Drainage and sewer systems	Sewer network plans. Lost river location plans.	Water companies (various) Local planning authority
Artificial sources	Reservoir inundation mapping (RIM). Canal infrastructure locations. Trunk water main asset plans.	Environment Agency Canal & River Trust Water companies (various)

4.2 Site familiarisation visits

4.2.1 No site familiarisation visits have been carried out within this study area.

5 The proposed development

5.1 Topography and land use

5.1.1 The character within the study area is rural landscape interspersed with scattered cottages, farmsteads and villages. The predominant land use is mixed agriculture. The topography is characteristically gently rounded as the land rises from the Colne Valley into the Chilterns Hills.

5.1.2 The River Misbourne and its tributaries flow through the Chalfonts and Amersham area and the route will pass beneath the River Misbourne, in tunnel, at Chalfont St Giles and again at the Shardeloes Estate.

5.2 Local flood risk receptors

5.2.1 The vulnerability of each local receptor with an identified pathway within the study area is presented in Table 3. The vulnerability is classified in accordance with the recommendations of Table 2 in the NPPF Technical Guidance Document and the Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

Table 3: Vulnerability of local receptors in CFA8

Local receptor	Description	Vulnerability classification	Source/pathway
Three Oaks Farm	Residential dwelling and associated land.	More vulnerable	Surface water flooding 30 years - shallow
Tubbs Cottages	Residential dwelling and associated land.	More vulnerable	Surface water flooding 30 years - shallow
Skippings Farm	Residential dwelling and associated land.	More vulnerable	Surface water flooding 30 years - shallow
Turners Wood Farm	Residential dwelling and associated agricultural land.	More vulnerable	Surface water flooding 200 years - shallow
London Road, Chalfont St Giles	Residential dwellings and associated gardens along the western side of London Road.	More vulnerable	Groundwater - very high
Chalfont St Giles urban areas along Dean Way, Stratton Chase Drive and Kings Road	Numerous dry valleys and tributaries leading into River Misbourne.	More vulnerable	Surface water flooding 30 years -shallow
High Street and The Green, Chalfont St Giles	Residential properties, businesses and public buildings including Chalfont St Giles Library.	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir

Local receptor	Description	Vulnerability classification	Source/pathway
Townfield Lane, Lapraik Grove, Bowstridge Lane, western end of the High Street, Up Corner Close and Stratton Chase Drive	Residential properties businesses, and public buildings including The Crown Public House, St Giles Church and doctors surgery.	More vulnerable	Groundwater - very high
Mill House Farm, The Old Mill and properties at the north-east end of Mill Lane	Residential dwellings	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir
Misbourne Farm	Residential dwelling and associated outbuildings and land.	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir
Amersham Road (A413)	Residential and industrial dwellings, predominantly along western side of Amersham Road and The Ivy House Pub and bed and breakfast.	More vulnerable	Groundwater - very high
Lower Bottom House Farm	Residential dwelling and associated outbuildings.	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high
Upper Bottom House Farm and Chalfont Valley Equestrian	Residential dwelling, associated outbuildings and livery yard.	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - moderate to high
Hobbs Hole	Access to residential dwelling.	More vulnerable	Surface water flooding 30 years - deep
Amersham Old Town, High Street and Broadway	Residential dwellings and commercial properties.	More vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir
Amersham Old Town urban area	Residential dwellings and commercial properties.	More vulnerable	Groundwater - very high

Local receptor	Description	Vulnerability classification	Source/pathway
Whielden Street, Amersham Old Town	Residential dwellings and access.	More vulnerable	Surface water flooding 30 years - shallow Groundwater - very high
Amersham Hospital	Amersham Hospital car park and front of building.	More vulnerable	Surface water flooding 30 years - deep Groundwater - high to very high
The Chilterns Crematorium cottages	2 residential dwellings and proposed gardens and outbuilding	More vulnerable	Surface water flooding 30 years - deep
Shardeloes East Lodges	Residential dwellings close to Amersham Cricket Club	More vulnerable	Fluvial Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir failure
Amersham Cricket Club	Cricket ground and pavilion	Water compatible	Fluvial Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir failure

5.3 Description of the Proposed Scheme

5.3.1 The Proposed Scheme through the study area will be 11.3km in length. The key elements of the scheme are shown on Map CT-06-023 to Map CT-06-030 (Volume 2, CFA8 Map Book).

5.3.2 The route will be constructed in twin-bored tunnels beneath CFA8. The depth of the tunnels will vary between approximately 20m and 90m below ground level depending on surface topography and will be at least twice the bored tunnel diameter in depth beneath surface water features to ensure that the tunnels comply with relevant rail standards.

5.3.3 The Chiltern tunnel will commence south of the M25 between junctions 16 and 17 and east of Chalfont St Peter, in the Colne Valley (CFA7) area. From the M25, the route will continue north-west in tunnel to the north of Chalfont St Peter where the Chalfont St Peter vent shaft will be located approximately 50m from Chesham Lane to the south of Ashwell's Farm. Land drainage areas are located to the east and south of the vent shaft headhouse.

5.3.4 From the Chalfont St Peter vent shaft, the route will continue north-west within the Chiltern tunnel, past Chalfont St Giles to Bottom House Farm Lane. The Chalfont St Giles vent shaft will be located in an open field approximately 300m south-west of Upper Bottom House Farm. Land drainage areas will be located to the north and south of the vent shaft headhouse.

5.3.5 From the Chalfont St Giles vent shaft, the route will continue north-west within the Chiltern tunnel, up to the A404 Whielden Lane, south of Amersham Old Town. The Amersham vent shaft will be located in the isolated parcel of land at the junction of the A404 Whielden Lane and the A413, south of Amersham Hospital. Land drainage areas are located to the east and south of the vent shaft headhouse.

5.3.6 Within the study area the route will be tunnelled beneath the River Misbourne in two places.

6 Existing flood risk

6.1 Historical flooding incidents

6.1.1 The only flood event in Buckinghamshire which is considered to have had significant harmful consequences is the groundwater dominated flood event which occurred in the winter of 2000-2001. The ChDC SFRA identifies specific issues of river flooding from the River Misbourne, in particular, a significant historical event at Chalfont St Giles in 2001. The route will pass beneath the River Misbourne at Chalfont St Giles and east of Little Missenden, with a minimum cover of around 20m between the top of the tunnels and the river bed.

6.1.2 There are a number of recorded incidents of surface water flooding recorded in the BuCC PFRA within the urban areas of Chalfont St Giles and Chalfont St Peter during flood events in 2006 and 2007. Additionally, there are a small number recorded within Amersham Old Town. The ChDC SFRA reports that the High Street and Broadway in Amersham Old Town suffer from surface water flooding during heavy rainfall. In Chalfont St Giles, surface water flooding of roads is reportedly due to poor drainage, raised groundwater levels and runoff from local fields. The steep topography around Chalfont St Peter means that the town is susceptible to surface water flooding which is exacerbated when groundwater levels are high. Several roads and properties have flooded in the past and the ChDC SFRA indicates that the poor state of the local drainage network could be a contributing factor.

6.1.3 Rising groundwater levels in the district have directly caused, or exacerbated, flooding within basements within Amersham Old Town and at the foot of Gravel Hill in Chalfont St Peter.

6.1.4 Thames Water Utilities Limited (TWUL) historical DG5 sewer flooding records show that there have been a small number of sewer flooding incidents within this study area. These are not recorded precisely within either the ChDC SFRA or the BuCC PFRA. The ChDC SFRA data, however, indicates there are records for one or two properties only. The BuCC PFRA concludes that sewer flooding across Buckinghamshire generally appears to be sporadic and infrequent.

6.2 Risk of flooding from rivers

6.2.1 The River Misbourne and its tributaries flow though the Chalfonts and Amersham area. The route passes beneath the River Misbourne (an Environment Agency Main River) at Chalfont St Giles (SWC-CFA8-01), and at Shardeloes Grade II* registered park and garden (SWC-CFA8-02) near the northern end of the study area to the north-west of Amersham.

6.2.2 The Proposed Scheme will cross approximately 410m and 460m respectively of Flood Zones 2 and 3, however, since the Proposed Scheme will be wholly within tunnel beneath these areas there will be no risk of flooding to the Proposed Scheme arising from the River Misbourne.

6.2.3 A tributary of the River Misbourne runs alongside the Bottom House Farm Lane and the entire length from the A413 Amersham Road to Upper Bottom House Farm lies within Flood Zones 2 and 3.

6.3 Risk of flooding from surface water

6.3.1 The Proposed Scheme will pass beneath a number of dry valleys and tributary ditches of the River Misbourne within this study area that are shown on the FMfSW to be at risk of surface water flooding for both the 1 in 30 years return period (3.3% annual probability) and 1 in 200 years return period (0.5% annual probability) rainfall events. This has been reviewed to form the basis of the assessment of the impact on the risk of surface water flooding. As the Proposed Scheme is within tunnel for the majority of CFA8, the surface water flood risk to the Proposed Scheme has been considered only in the location of permanent above-ground infrastructure. The most notable dry valleys that are shown to be at risk of surface water flooding are close to the Chalfont St Giles vent shaft and the Amersham vent shaft.

Chalfont St Peter vent shaft

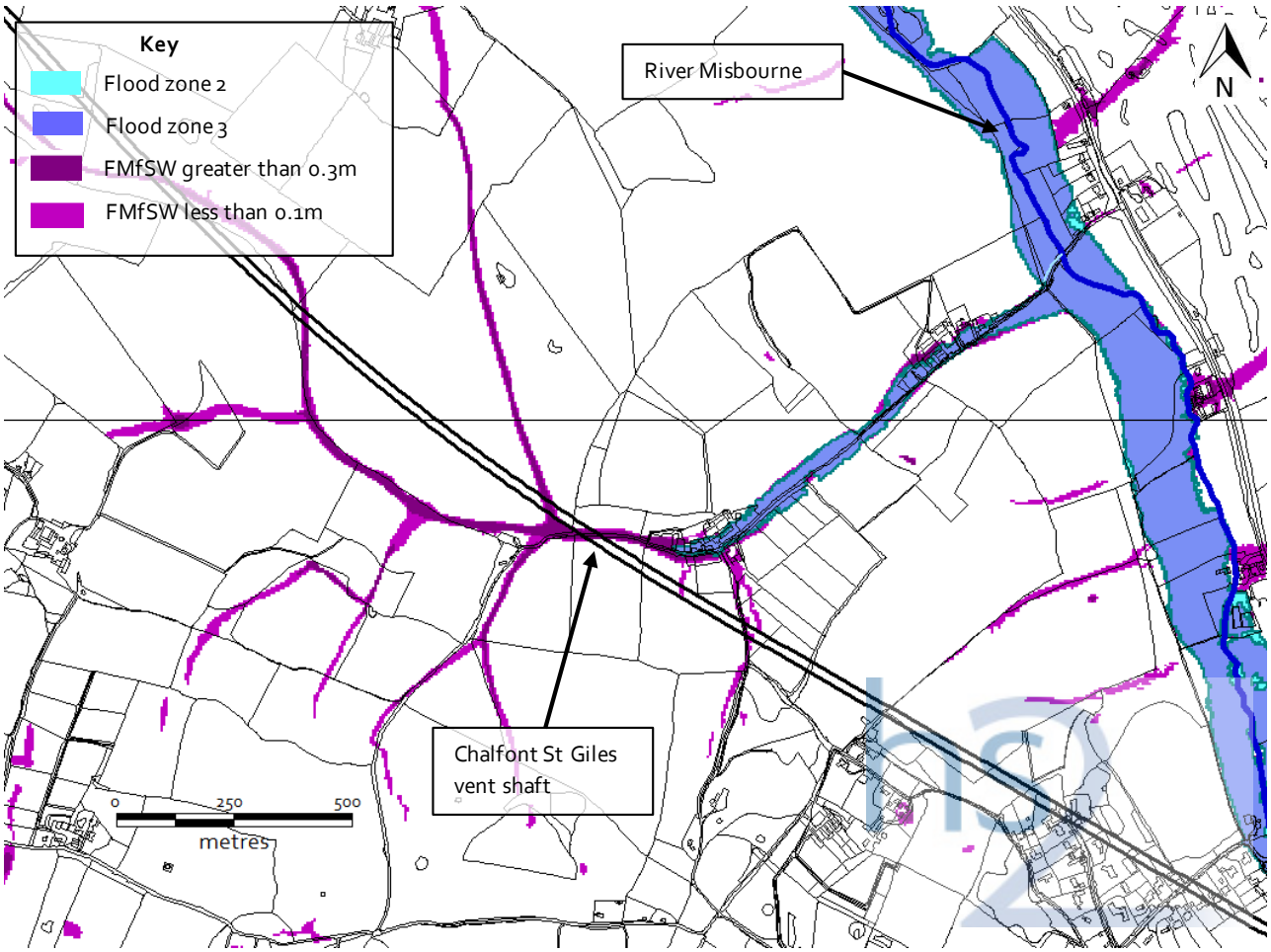
6.3.2 Locally agreed surface water information datasets from the BuCC PFRA and the Environment Agency FMfSW identify dry valleys and tributaries that are susceptible to surface water flooding. The Chalfont St Peter vent shaft will be located to the west of Chesham Lane, at the northern edge of Chalfont St Peter close to Turners Wood Farm, as shown on Map CT-06-24 (Volume 2, CFA8 Map Book). Turners Wood Farm is located within a dry valley which is susceptible to surface water flooding for the 1 in 30 years return period (3.3% annual probability) and 1 in 200 years return period (0.5% annual probability) rainfall events. The vent shaft, however, will be located on higher ground approximately 70m from the closest area at risk of surface water flooding.

6.3.3 There will consequently be no significant risk of surface water flooding to the Proposed Scheme at the Chalfont St Peter vent shaft.

Chalfont St Giles vent shaft

6.3.4 The Chalfont St Giles vent shaft will be located close to the north-west of Chalfont St Giles, close to Upper Bottom Farm, as shown on Map CT-06-26 (Volume 2, CFA8 Map Book). The ground level profiles suggest that the ground level at the location of the vent shaft is around 96m AOD. The permanent structure of the Chalfont St Giles vent shaft will be located within a dry valley that is at risk of surface water flooding for the 1 in 30 years return period (3.3% annual probability) and 1 in 200 years return period (0.5% annual probability) rainfall events (shown on Figure 2). This dry valley is one of a number that converge immediately down-gradient of the shaft headhouse. The shaft and its associated access hardstanding will intersect the entire dry valley preventing natural overland flow.

Figure 2: 1 in 200 years return period (0.5% annual probability) surface water flood extent and Environment Agency Flood Zone Map at Chalfont St Giles vent shaft



6.3.6 The FMfSW indicates the potential for surface water flooding depths of greater than 0.3m in the 1 in 30 years return period (3.3% annual probability) rainfall event. There will therefore be a high risk of surface water flooding to the Proposed Scheme at the Chalfont St Giles vent shaft.

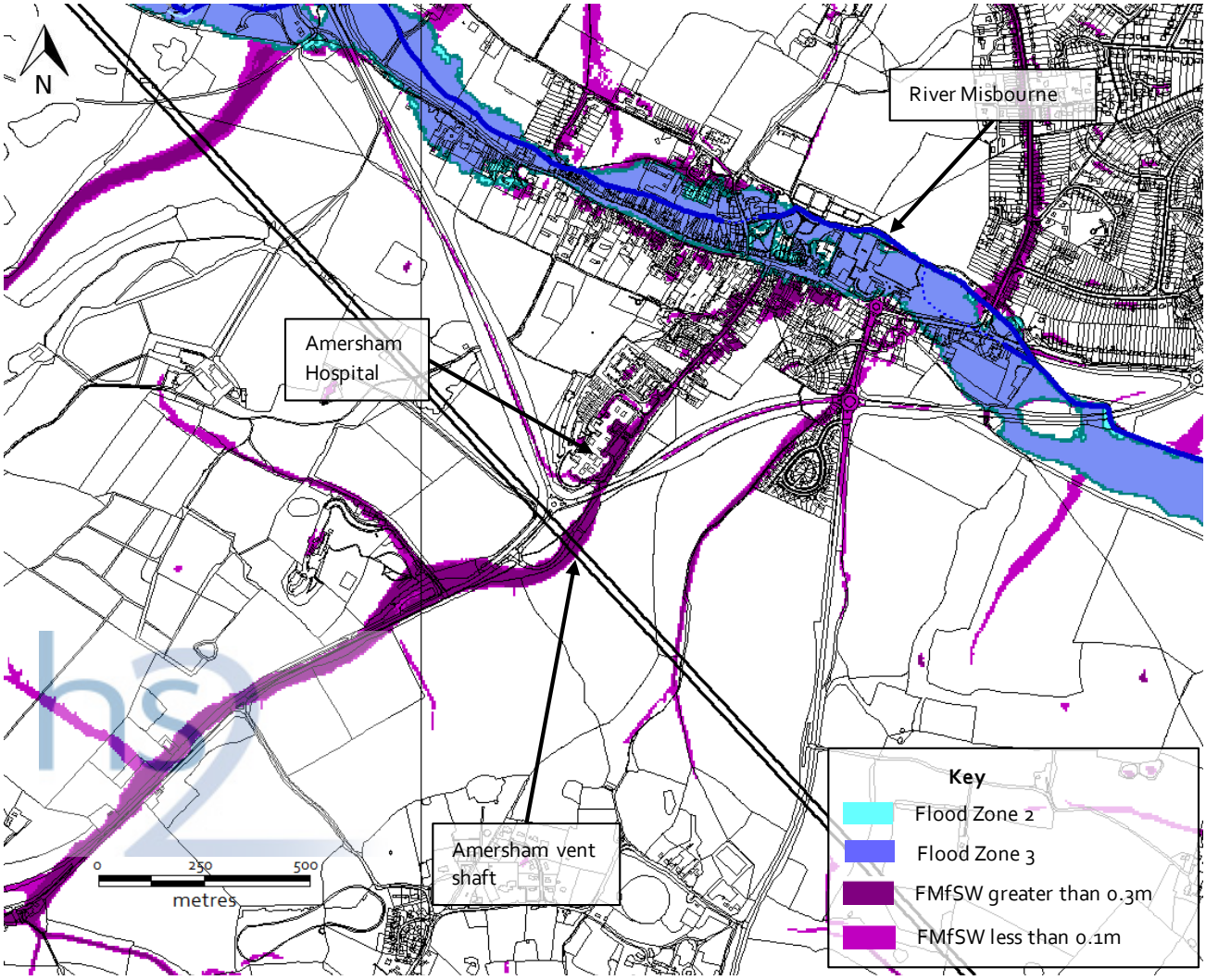
6.3.7 Bottom House Farm Lane, which is to be widened as part of the Proposed Scheme in order to allow access to the Chalfont St Giles vent shaft, is at risk of surface water flooding during the 1 in 30 years rainfall event in addition to the risk of river flooding from the Misbourne tributary. The FMfSW indicates that deep flooding (>0.3m) is likely close to Upper Bottom House Farm and along the road adjacent to Lower Bottom House Farm. As with the risk of river flooding, the risk of the road flooding will be of consideration during construction. There will, however, be no significant additional risk of flooding to the Proposed Scheme, which will be in tunnel at this location.

Amersham vent shaft

6.3.8 The Amersham vent shaft will be located at the intersection of the A404 Whielden Lane and A413 London Road East, just outside Amersham Old Town, as shown on

Map CT-06-28 (Volume 2, CFA8 Map Book). The vent shaft will be located close to a dry valley that is at risk of surface water flooding for the 1 in 30 years return period (3.3% annual probability) and 1 in 200 years return period (0.5% annual probability) rainfall events (Figure 3).

Figure 3: 1 in 200 years return period (0.5% annual probability) surface water flood extent and Environment Agency Flood Zone Map at Amersham vent shaft



6.3.9 This dry valley follows the course of the A404 Whielden Lane, which is in cutting close to the location of the proposed vent shaft. The FMfSW indicates the potential for surface water flooding depths of greater than 0.3m in the 1 in 30 years return period (3.3% annual probability) rainfall event. The proposed vent shaft headhouse, however, will be located on raised land just outside of the area at risk of surface water flooding.

6.3.10 Therefore, there will be no significant risk of surface water flooding to the Proposed Scheme at the Amersham vent shaft.

6.4 Risk of flooding from groundwater

6.4.1 Flooding from groundwater occurred within the Chilterns in the winter of 2000-2001 and the ChDC SFRA notes that there have been flooding incidents recorded in Old Amersham due to rising water table levels. Rising groundwater levels in the district have directly caused, or exacerbated, flooding within basements within Amersham Old Town and at the foot of Gravel Hill in Chalfont St Peter.

6.4.2 There are limited superficial deposits within the area comprising glacial sands and gravels, river terrace deposits, Clay-with-Flints and alluvium. Shallow groundwater could exist within the sandier layers of these groups and, where present, may be in hydraulic connectivity with the underlying Chalk. The superficial deposits are designated as secondary aquifers. Further details can be found in the CFA8 Water Resources Assessment (Volume 5: Appendix WR-002-008).

6.4.3 Groundwater levels are above the top of the proposed tunnels in this area with maximum recorded groundwater levels measured in winter 2000/2001 at 67m AOD at Chalfont St Peter, rising to 97m AOD near Amersham. Groundwater flow is generally to the south-east with a local pattern of flow towards the River Misbourne. Groundwater flow within the Chalk is predominantly through fractures and can be rapid.

6.4.4 The Proposed Scheme will be wholly within tunnel throughout CFA8 and tunnel walls will be sealed to block the passage of groundwater. The tunnelled section will therefore not be at risk of flooding due to groundwater.

6.4.5 Both the Chalfont St Giles and Amersham vent shafts will be located within areas identified as susceptible to groundwater flooding by the BuCC PFRA. This vulnerability area follows the River Misbourne valley, where groundwater is likely to emerge, along with dry valleys and tributaries. BGS datasets indicate that all three vent shafts are located above permeable soils, however the vent shafts at Chalfont St Peter and Chalfont St Giles will be located in areas at 'very low' risk of flooding due to groundwater. There will therefore be a low risk of groundwater flooding to the Proposed Scheme at Chalfont St Peter and Chalfont St Giles vent shafts.

6.4.6 Amersham vent shaft will be situated in an area at 'moderate' risk of groundwater emergence located along Whielden Lane. This road is at risk of flooding due to groundwater emerging from the superficial, 'Secondary A' drift deposits within the dry valley and emergent flooding could extend far enough to impact upon the headhouse. There will therefore be a medium risk of groundwater flooding to the Proposed Scheme at Amersham vent shaft.

6.4.7 Bottom House Farm Lane is located along a base of a valley which drains towards the River Misbourne. The BGS susceptibility to groundwater flooding maps show that the road is at 'very high' risk of flooding due to groundwater emergence from the bedrock aquifer along the length of the valley. The bedrock formation is classified as the Lewes Nodular Chalk Formation and is designated a 'Principal Aquifer'. Since the road lies along a principal bedrock aquifer, groundwater flooding along the base of this valley has the potential to be significant. Bottom House Farm Lane is therefore at a high risk

of flooding from groundwater. As with the risk of river and surface water flooding, the risk of the road flooding will be of consideration during construction. There will be, however, no significant additional risk of flooding to the Proposed Scheme, which will be in tunnel at this location.

6.5 Risk of flooding from drainage systems

6.5.1 The BuCC PFRA states that properties and infrastructure within ChDC are at risk of flooding due to the surcharging of the underground sewer system which results in overland flow.

6.5.2 TWUL historical DG5 sewer flooding records show that there have been a small number of sewer flooding incidents within this study area. Precise locations are not recorded within either the ChDC SFRA or the BuCC PFRA. The ChDC SFRA, however, indicates that only a few houses were flooded in each location. The ChDC SFRA therefore concludes that sewer flooding in the region appears to be sporadic and rare.

6.5.3 The Proposed Scheme will largely pass through rural areas and will be wholly within tunnel. The three vent shafts will also be located away from urban areas and properties. There will therefore be no risk of flooding from drainage and sewer systems to the Proposed Scheme within CFA8.

6.6 Risk of flooding from artificial sources

6.6.1 The route will cross an area that is shown in the Environment Agency RIM to be at risk of flooding in the event of failure of the Shardeloes Lake flood storage reservoir to the west of Amersham.

6.6.2 The maximum extent of flooding follows the valley of the River Misbourne downstream of the lake. Since the Proposed Scheme will be in tunnel through CFA8 and in particular at crossing locations of the River Misbourne, there will be no risk of flooding to the Proposed Scheme due to failure of Shardeloes Lake or any other artificial sources.

6.7 Summary of baseline flood risk

Table 4: Summary of baseline flood risk for all sources of flooding in CFA8

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
River flooding	Tributary to River Misbourne	High Flood Zone 3	Bottom House Farm Lane road widening	Widened road will be within Flood Zone 3 and at risk of flooding. Risk during construction phase but no additional risk to Proposed Scheme that will be in tunnel.

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
Surface water flooding	High ground surrounding Bottom House Farm Lane	High 30 years FMfSW>0.3m	Bottom House Farm Lane road widening	Access road will be located at the base of a valley that is at risk of overland flooding from the surrounding high ground. Risk during construction phase but no additional risk to Proposed Scheme that will be in tunnel.
	Land above Upper Bottom House Farm	High 30 years FMfSW>0.3m	Chalfont St Giles vent shaft	Vent shaft will be located at intersection of several dry valleys.
Groundwater	Base of valley which contains Bottom House Farm Lane	High Very high susceptibility	Bottom House Farm Lane road widening	Widened road will be located along the base of a valley where there is potential for significant groundwater emergence. Risk during construction phase but no additional risk to Proposed Scheme that will be in tunnel.
	A404 (Whielden Lane) dry valley	Medium Moderate susceptibility	Amersham vent shaft	Potential for groundwater to emerge along dry valley.

7 Flood risk management measures

7.1 Risk of flooding from rivers

7.1.1 There will be no instances where the tunnels or vent shafts of the Proposed Scheme will be at significant risk of river flooding and consequently no mitigation will be required.

7.1.2 Bottom House Farm Lane is at risk of river flooding from a tributary of the River Misbourne, however, this is not anticipated to worsen as a result of the road widening works and there is expected to be no increase in risk to third party receptors. Therefore, no specific mitigation will be required.

7.2 Risk of flooding from surface water

7.2.1 The FMfSW shows the extent of flooding due to rainfall that would occur prior to collection of water into streams or designated drainage infrastructure. By collecting the flows from the dry valley into an adequately designed land drainage system, the Proposed Scheme will effectively remove the risk of surface water flooding from the point at which the flow is intercepted.

7.2.2 Measures to manage the risk of flooding from surface water runoff include:

- provision of replacement storage and surface water attenuation facilities to restrict peak surface water runoff rates to existing greenfield sites;
- culverts have been designed with adequate capacity to convey the 1 in 100 years (1% annual probability) flow including an allowance for climate change; and
- design of culverts with internal 600mm freeboard and 300mm allowance for siltation to minimise the chances of blockage or future capacity restrictions.

7.2.3 The vent shaft located at Chalfont St Giles will potentially be at risk of flooding in an intense rainfall event. Management measures to ensure there will be no significant risk of flooding to the Proposed Scheme include:

- raising the threshold of the vent house at least 300mm above surrounding ground levels; and
- ensuring there are no openings below this raised threshold and the structure will be flood-proofed below this level to ensure no ingress of surface water in a heavy rainfall event.

7.2.4 Proposed landscape reprofiling to the north-west of Chalfont St Giles vent shaft headhouse (up-gradient) will slightly alter the surface water flowpaths down the dry valley towards the vent shaft. The design includes land drainage at the base of the reprofiled bank in the form of swales and overland flows will be collected by drainage around the vent shaft headhouse, as shown on Map CT-06-026 (Volume 2, CFA8 Map Book).The collected surface water flows will drain to the ditch along Bottom House

Farm Lane and will maintain connectivity from this catchment with the River Misbourne.

7.3 Risk of flooding from groundwater

7.3.1 There is a risk of flooding arising from an area of moderate susceptibility to groundwater emergence along the dry valley running along Whielden Lane adjacent to the proposed Amersham vent shaft. Due to the steep gradients in the area, emergent groundwater will generally be expected to follow established overland flow routes, causing only shallow flooding. Management measures to ensure there will be no significant risk of flooding to the Amersham vent shaft include:

- raising the threshold of the vent house at least 300mm above surrounding ground levels; and
- ensuring there are no openings below this raised threshold and the structure will be flood-proofed below this level to ensure no ingress of groundwater emerging at the surface as a result of a high water table.

7.3.2 Dewatering of vent shafts will be required during construction and groundwater will be recharged to the aquifer via a series of wells in the vicinity of the vent shafts. As a result, there will be no impact on groundwater flooding.

7.3.3 There will not be any significant impact on the risk of flooding from groundwater to third party receptors arising from the Proposed Scheme and therefore no specific mitigation will be required.

7.4 Risk of flooding from drainage systems

7.4.1 There will be no risk of flooding from drainage systems to the Proposed Scheme, nor will there be any anticipated effects on the risks of flooding from drainage systems within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.5 Risk of flooding from artificial sources

7.5.1 There are no instances where the Proposed Scheme will be at significant risk of flooding from artificial sources, nor will there be any anticipated effects on the risks of flooding from artificial sources within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

8 Post-development flood risk assessment

8.1 Local receptors

8.1.1 In addition to the risk of flooding that exists to the Proposed Scheme, there is potential for the Proposed Scheme to affect the risk of flooding to third party receptors by altering flow mechanisms across the range of flood sources. All local receptors with a potential flood risk are identified in Section 5.2 of this report. For the Proposed Scheme to have an impact on a given receptor the identified pathway for that receptor must be shared by both the subject receptor and the Proposed Scheme, with the result that a number of cases can be excluded immediately. Table 5 summarises the shared pathways between the Proposed Scheme and each receptor, and identifies cases where no shared pathway exists.

Table 5: Shared flood risk pathways in CFA8

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Three Oaks Farm	More Vulnerable	Surface water flooding 30 years -shallow	No shared pathway (Proposed Scheme will be in tunnel).
Tubbs Cottages	More Vulnerable	Surface water flooding 30 years - shallow	No shared pathway (Proposed Scheme will be in tunnel).
Skippings Farm	More Vulnerable	Surface water flooding 30 years -shallow	No shared pathway (Proposed Scheme will be in tunnel).
Turners Wood Farm	More Vulnerable	Surface water flooding 200 years - shallow	No shared pathway (Chalfont St Peter vent shaft will be upstream of area of risk of flooding from surface water).
London Road, Chalfont St Giles	More Vulnerable	Groundwater - very high	Potential effects arising from the Proposed Scheme tunnels.
Chalfont St Giles urban areas along Dean Way, Stratton Chase Drive and Kings Road	More Vulnerable	Surface water flooding 30 years - shallow	No shared pathway (Proposed Scheme will be in tunnel).
High Street and The Green, Chalfont St Giles	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years -deep Groundwater - very high Shardeloes Lake flood storage reservoir	Groundwater only (Proposed Scheme will be in tunnel).
Townfield Lane, Lapraik Grove, Bowstridge Lane, western end of the High Street, Up Corner Close and Stratton Chase Drive	More Vulnerable	Groundwater - very high	Potential effects arising from the Proposed Scheme tunnels.

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Mill House Farm, The Old Mill and properties at the north-east end of Mill Lane	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir	Possible increase in groundwater levels above tunnel section on upstream side of River Misbourne Valley. Groundwater only (Proposed Scheme will be in tunnel).
Misbourne Farm	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir	Groundwater only (Proposed Scheme will be in tunnel).
Amersham Road (A413)	More Vulnerable	Groundwater - very high	Groundwater only (Proposed Scheme will be in tunnel).
Lower Bottom House Farm	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high	Chalfont St Giles vent shaft will be approximately 650m upstream.
Upper Bottom House Farm and Chalfont Valley Equestrian	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - moderate to high	Chalfont St Giles vent shaft will be approximately 250m upstream.
Hobbs Hole	More Vulnerable	Surface water flooding 30 years - deep	Access to the property at Hobbs Hole will be restricted due to surface water flooding of Bottom House Farm Lane, which will be downstream of Chalfont St Giles vent shaft.
Amersham Old Town, High Street and Broadway	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir	Groundwater only (Proposed Scheme will be tunnel and vent shaft outside of risk areas or significant hydraulic distance).
Amersham Old Town urban area	More Vulnerable	Groundwater - very high	Potential effects arising from the Proposed Scheme tunnels.

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Whielden Street, Amersham Old Town	More Vulnerable	Surface water flooding 30 years - shallow Groundwater - very high	Groundwater only (Proposed Scheme will be in tunnel and vent shaft outside of risk areas).
Amersham Hospital	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - high to very high	Groundwater only (Proposed Scheme will be in tunnel and vent shaft outside of risk areas).
The Chilterns Crematorium cottages	More Vulnerable	Surface water flooding 30 years - deep	No shared pathway (upstream of Amersham vent shaft).
Shardeloes East Lodges	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir	Groundwater only (Proposed Scheme will be in tunnel).
Amersham Cricket Club	Water-compatible	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir	Groundwater only (Proposed Scheme will be in tunnel).

8.1.2 There is also the potential for the Proposed Scheme to change the baseline risk of flooding described in the Section 6 of this report. Though designed such that the probability of the Proposed Scheme flooding in any given year is less than 1 in 1,000, any change to the baseline risk of flooding could impact on the assessment of flood risk to the Proposed Scheme. All cases of flood risk discussed in Section 6 of this report are therefore reconsidered regardless of the presence or otherwise of third party local receptors.

8.2 Impact on risk of flooding from rivers

8.2.1 The widening of Bottom House Farm Lane will remain once construction is completed. A tributary of the River Misbourne runs alongside the existing road and the entire length of Bottom House Farm Lane from the A413 to Upper Bottom House Farm lies within Flood Zones 3 and 2.

8.2.2 The roadway, including verges, will be widened by up to 2m. The existing ditch will be reinstated alongside the road, and it is not anticipated that any land raising within the floodplain will be required. Although the road is at risk of flooding, there will be no

significant impact on the risk of flooding to third party receptors or increase in the existing risk as a result of the widening works. The roadway at the bridge over the River Misbourne will also be widened; however, the existing supporting structure will remain in place, subject to the need for strengthening works. The potential impact of the road widening on the risk of river flooding will therefore be negligible.

8.2.3 Since the route will be wholly within tunnel and will not cross any Environment Agency designated main rivers or ordinary watercourses within this study area, the Proposed Scheme will not lead to a change in the risk of flooding from rivers, excluding potential groundwater effects.

8.3 Impact on risk of flooding from surface water

8.3.1 The above ground infrastructure has the potential to alter overland flow routes, thereby changing the risk of flooding to local receptors. Surface water runoff from all permanent structures will be controlled at source by design thus preventing increased rates and volumes of surface water runoff to the local sewer network or above ground receptors.

8.3.2 The widening of Bottom House Farm Lane will remain once construction is completed. Although the road is at risk of flooding, there will be no significant impact on the risk of flooding due to overland flow to third party receptors, or increase in the existing risk as a result of the widening works. Any additional runoff created as a result of the additional hardstanding area will be collected by the surface water drainage system. The impact of the road widening on the risk of surface water flooding will therefore be negligible.

Chalfont St Peter vent shaft

8.3.3 The permanent structure of the Chalfont St Peter vent shaft will be located at the top of a hill, up-gradient of any area at risk of surface water flooding. Runoff from the vent headhouse itself and any associated hardstanding will be collected, attenuated and discharged in accordance with the necessary approvals and consents. There will therefore not be any adverse impacts on the risk of surface water flooding at Chalfont St Peter vent shaft.

Chalfont St Giles vent shaft

8.3.4 The permanent structure of the Chalfont St Giles vent shaft will be located within a dry valley that is at risk of flooding for the 1 in 30 years return period (3.3% annual probability) and 1 in 200 years return period (0.5% annual probability) rainfall events. This dry valley is one of a number that converge immediately down-gradient of the shaft headhouse. The vent shaft and its associated access landscaping and reprofiling will intersect the entire dry valley and will marginally alter the natural overland flow paths. Measures are provided to intercept overland flow in the form of drainage around the vent shaft headhouse. This will be discharged to the ditch along Bottom House Farm Lane, maintaining connectivity of the catchment with the River Misbourne. It is not anticipated that the proposed landscaping will cause displacement of overland flow onto the neighbouring property at Hobbs Hole, which lies up-

gradient of the proposed landscaping. As a result, there will be no significant impact on the volume, rate or depth of surface water flooding in the vicinity of the vent shaft.

8.3.5 The property at Upper Bottom House Farm is currently at risk of surface water flooding as a result of overland flow from surrounding high ground flowing down the dry valleys and along Bottom House Farm Lane. Although the proposed shaft headhouse will result in minor diversion of overland flows there will be no increase in the risk of flooding downstream of the Proposed Scheme. There will therefore be no significant change in the volume, rate or depth of flooding at this property as a result of the Proposed Scheme.

8.3.6 There will not be any further anticipated changes to the risk of flooding from surface water sources as a result of the Proposed Scheme and therefore no significant impact on the risk of flooding to third party receptors.

Amersham vent shaft

8.3.7 The Amersham vent shaft will be located within a dry valley that follows the course of the A404 Whielden Lane, which is in cutting close to the location of the proposed vent shaft. The proposed vent shaft itself will be located on higher ground outside of the area at risk of surface water flooding and consequently will not obstruct or displace floodwaters. Runoff from the vent headhouse itself and any associated hardstanding, will be collected, attenuated and discharged in accordance with the necessary approvals and consents.

8.3.8 There will be no significant impact on the risk of flooding to third party receptors, including Amersham Hospital, or increase in the existing risk as a result of the Proposed Scheme.

8.4 Impact on risk of flooding from groundwater

8.4.1 There is a high risk of groundwater flooding along the length of Bottom House Farm Lane as a result of emergence from the principal aquifer during times of high groundwater levels. Although the road and entire base of the valley is at risk of flooding there is not expected to be an increase in the existing risk as a result of the widening works. As a result, there will be no significant effect on the risk of flooding from groundwater.

8.4.2 Amersham vent shaft will be situated in an area at medium risk of groundwater emergence from the superficial aquifer beneath Whielden Lane. The CFA8 Water Resources Assessment (Volume 5: Appendix WR-002-008) concludes that due to the extent of the aquifer relative to the size of the tunnels, vent shafts and cross passages, groundwater flows are only likely to be locally affected by their presence, resulting in a neutral effect. As a result there will be a neutral effect on the risk of flooding from groundwater.

8.4.3 The BGS dataset indicates that the Proposed Scheme tunnels will pass under areas of 'very high' susceptibility to flooding from groundwater within the consolidated (bedrock) aquifer along the River Misbourne valley. Although the tunnel design passes through the 'Principal A aquifer' below the groundwater table, the cross-sectional area of the tunnels is relatively small in comparison with the assumed effective thickness

and extent of the Chalk aquifer. The tunnel will therefore not be expected to significantly affect groundwater flows at a broad scale.

8.4.4 On a more local scale, there may be a tendency for groundwater levels to rise slightly in the areas around the River Misbourne valley, due to the location of the tunnel closer to the ground surface, possibly causing spring flows to appear immediately upstream of the tunnel in some locations. The impact will be restricted to the immediate vicinity of the tunnel; however this is of particular concern in Chalfont St Giles, where properties on Mill Lane lie on the upstream side of the tunnel.

8.4.5 Groundwater analysis undertaken as part of the CFA8 Water Resources Assessment (Volume 5: Appendix WR-002-008) confirms that the change to groundwater head within the immediate vicinity of the tunnel (up-hydraulic gradient) would be less than 4.5cm. It is considered unlikely that this local increase in groundwater head level will have a significant impact on the extent of the area at 'very high' risk of susceptibility to groundwater flooding due to the steep gradients typical to the area. Therefore, there is unlikely to be a significant change from the current extent of flooding observed in Chalfont St Giles.

8.4.6 There will be a negligible impact on groundwater flows and levels in areas away from the river and it is not anticipated that there will be significant displacement of groundwater. As such, the Proposed Scheme will not cause a significant increase in groundwater emergence or flooding and there will be no significant impacts on the risk of flooding to third party receptors.

8.5 Impact on risk of flooding from drainage systems

8.5.1 Connections to the foul and surface water sewer network from the shaft headhouses within CFA8 will be agreed with TWUL prior to construction. The Proposed Scheme will therefore not lead to a change in the risk of flooding from drainage and sewer systems.

8.5.2 The route will be largely within a rural area and wholly within tunnel. The three vent shafts will also be located away from urban areas and properties. Consents to discharge will be obtained prior to construction from the necessary statutory authorities to ensure that there is sufficient capacity in the receiving infrastructure. This will prevent any increase in the risk of sewer flooding to local receptors.

8.6 Impact on risk of flooding from artificial sources

8.6.1 Settlement contours of the tunnel marginally encroach on the southern side of Shardeloes Lake. The settlement contour on the northern side of the tunnel is approximately 100m south of the dam embankment and the risk of damage to the dam is considered negligible. Due to the rising ground levels to the south of the lake, any escape of water to the surface is also considered negligible.

8.6.2 The effect of the Proposed Scheme on the residual risk of the lake failing is therefore neutral and there will be no significant effect on the risk of flooding due to failure of Shardeloes Lake.

8.7 Summary of potential impacts and effects on flood risk

Table 6: Summary of potential flood risk impacts and effects in CFA8

Receptor	Vulnerability classification	Pathway	Impacts and effects
General Proposed Scheme	N/A	River flooding	No significant effects expected.
		Surface water flooding	Potential impact on surface water flooding due to landscaping upstream of Chalfont St Giles vent shaft headhouse, mitigated by interception of overland flow in the vent shaft drainage system. No significant effect.
		Groundwater	Localised increases in groundwater emergence immediately upstream of the tunnels at the base of the River Misbourne valley. No significant effect.
		Drainage Systems	No significant effects.
		Artificial sources	No significant effects.
Mill House Farm, The Old Mill and properties at the north-east end of Mill Lane	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high Shardeloes Lake flood storage reservoir failure	Slight increase in groundwater levels above tunnel section on upstream side of River Misbourne Valley, however, no significant effects expected as a result.
Lower Bottom House Farm	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - very high	No significant effects.
Upper Bottom House Farm and Chalfont Valley Equestrian	More Vulnerable	River flooding Flood Zone 3 Surface water flooding 30 years - deep Groundwater - moderate to high	No significant effects.

Receptor	Vulnerability classification	Pathway	Impacts and effects
Hobbs Hole	More Vulnerable	Surface water flooding 30 years - deep	No significant effects.
Whielden Street, Amersham Old Town	More Vulnerable	Groundwater - very high	No significant effects.
Amersham Hospital	More Vulnerable	Groundwater - high to very high	No significant effects.

9 Conclusions

9.1 Summary

9.1.1 The Proposed Scheme within CFA8 extends from the M25, east of Chalfont St Peter in the south-east, to the junction of the A413 Amersham Road and Mop End Lane in the north-west. The study area includes all areas within 1km of the Proposed Scheme, which includes areas at risk of flooding from various sources, as follows:

- areas at risk of river flooding from the River Misbourne from the main rivers and tributaries, one of which coincides with the widening of an access road for the Proposed Scheme;
- areas at risk of surface water flooding, one of which coincides with the location of a proposed vent shaft headhouse;
- areas susceptible to groundwater emergence and thus at risk of groundwater flooding, two of which coincide with areas of at-grade construction under the Proposed Scheme; and
- an area at risk of flooding in the event of failure of the Shardeloes Lake flood storage reservoir.

9.1.2 The Proposed Scheme will be predominantly in tunnel throughout the Chalfonts and Amersham area, with only three above-ground vent shaft locations. The Proposed Scheme will also include the widening of an existing road in order to facilitate access to one of the vent shafts.

9.1.3 There are some areas at risk of flooding from surface water runoff where the Proposed Scheme will be located within dry valleys, managed by providing sufficient capacity in the drainage system of the Proposed Scheme to collect, attenuate and discharge surface water to a suitable outfall subject to the necessary approvals and consents. Design standards are such that no flooding of the Proposed Scheme is expected under normal operating conditions. There is one instance where road widening, as part of the Proposed Scheme, will be at-grade with an area of very high susceptibility to groundwater emergence. However this widening is not expected to cause an increase in the depth, extent, frequency or duration of flooding.

9.1.4 The dominant land use within the Chalfonts and Amersham area is agriculture. There will be no third party receptors that will be significantly affected by the Proposed Scheme as a result of the majority being within tunnel. Mitigation will be provided to ensure that there is no flooding to the Proposed Scheme at the vent shaft headhouses, nor any increase in flooding to local receptors as a result of the Proposed Scheme.

9.2 Residual flood risks to Proposed Scheme

9.2.1 Residual flood risks arise in situations that are not included in standard design scenarios or infrastructure fails, for example when a culvert becomes blocked causing

flooding upstream. Consequently there may be areas where the potential severity of flooding may exceed the design standard under certain circumstances.

Residual flood risks from rivers

9.2.2 As the Proposed Scheme will be wholly within tunnel and the construction of the vent shaft headhouses will have no impact upon the River Misbourne, there will be no additional residual risks to the Proposed Scheme.

9.2.3 Bottom House Farm Lane crosses a bridge over the River Misbourne, which will also be widened; however, there will be no increase in the existing residual risk as a result of a blockage of existing bridge structures on the road or third party receptors.

Residual flood risks from surface water and minor watercourses

9.2.4 There are no significant hydraulic structures located near to the above-ground features of the Proposed Scheme that could pose a residual risk of flooding in the event of blockage or failure.

Residual flood risks from groundwater

9.2.5 There are no significant residual risks arising from groundwater.

Residual flood risks from drainage systems

9.2.6 Blockage of underground surface water collections systems can cause surcharge and associated flooding. There are no risks of flooding to the Proposed Scheme from drainage systems associated with existing infrastructure within the study area.

Residual flood risks from artificial and surface waterbodies

9.2.7 Within the study area the only area of flood risk associated with an artificial or surface waterbody is the inundation area associated with failure of Shardeloes Lake flood storage reservoir. The Environment Agency methodology considers the consequences of total failure of the reservoir and the baseline data therefore represents the residual risk.

9.3 Residual effects of the Proposed Scheme on flood risk

9.3.1 Following mitigation for impacts on the risk of flooding arising from the Proposed Scheme, there will be no residual effects on the risk of flooding with no overall residual effects on third party receptors.

9.4 Compliance with local planning policy

9.4.1 Since the Proposed Scheme is largely in tunnel throughout CFA8, there are no watercourse crossings and consequently allowances for climate change recommended in the NPPF Technical Guidance document are not required for river flows. The Proposed Scheme includes an allowance for future increases in the risk of flooding as a result of climate change by adding a 30% increase to rainfall intensities and flows in minor watercourses. SuDS, in the form of attenuation ponds and swales, as well as the creation of open channel land drainage, are used at the vent shaft locations.

9.4.2 In accordance with the Core Strategy for ChDC, consideration of local flooding as indicated by the CDA mapping for the ChDC SFRA, is an integral part of design. Consideration has been made to surface water flows down dry valleys and measures have been taken to ensure there is no increase in the risk of local surface water flooding.

10 References

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